Obsolescence Management the study of Power Utility in South Africa

A Minor Dissertation Submitted in Partial Fulfilment of the Degree of

MAGISTER INGENERIAE / MAGISTER PHILOSOPHIAE

in

ENGINEERING MANAGEMENT

at the

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

of the

UNIVERSITY of JOHANNESBURG

by

Student Name: N. Gantsho (215708438)

Date: 24/11/2017

SUPERVISOR: J.H. Pretorius

CO-SUPERVISOR: B. Makhanya

Abstract

Large organizations such as Power Utilities within South Africa are always striving to improve their strategies in order to be successful in running their businesses. Power Utilities commit to deliver services in time without fail. In order to achieve all that, Power Utilities businesses need to focus more on making sure that all power plants' systems and components within Power Utilities are always available to provide full services. However this process is sensitive to the ageing of the system and technology improvement.

The current study is aiming at identifying the approaches and strategies employed by the Power Utilities to manage obsolescence. The study further examines the relationship between operating strategy and obsolescence management strategy within the Power Utilities. It also identifies the areas of improvement to support the Power Utilities.

The study uses both qualitative and quantitative methods to answer the research questions. Data was collected through the online surveys and asset management systems from the Power Utilities. The study results show that the Power Utility adopted the reactive approach to manage obsolescence and the obsolescence management strategy did not support the corporate plan. The study identified the lack of awareness, dedicated team responsible for obsolescence management and funding, as major areas that needed improvement. It is recommended that the Power Utility adopt a more proactive approach to manage obsolescence and support the business objectives. Executive managers should identify the training programme which creates awareness about obsolescence management within the organisation and allocates teams to managing obsolescence.

Acknowledgements

I would like to thank the following people who contributed to making my dissertation possible.

God
My family
Prof J.H. Pretorius
B. Makhanya
C. Boesack

Table of Contents

List of Figures

List of Tables

Abbreviations

Df - Degree of Frequency
OEM - Original Equipment Manufacture

CHAPTER 1: INTRODUCTION

1.1 Background

The aim of this report is to analyse the current ways in which ageing is currently been planned and managed, and then look at strategies and new approaches that can be developed in order to improve the issues of obsolescence planning management, and of ageing of equipment in Power Utilities. This systematic management approach seeks to reduce the impact obsolescence has on the availability and reliability of plant equipment.

Technology obsolescence refers to equipment that are no longer compatible with other plant areas for plant operative ability due to ageing or revolving new technology and unavailability of spares even though it could still be in working condition. It generally occurs when a new product has been created to replace an older product [1].

Reasons for obsolescence occurrence include market change, over operation of equipment, technological evolution and environmental rules and limitations [1, 2]. It is very common that a situation of market alteration can lead to a decrease in demand for older products such that the economic production is not possible. Also, a newly developed generation of technology renders the old one obsolete and sometimes these new technologies are often cheaper to produce than their forerunners. Furthermore, lack of foresight on obsolete critical power plant components, government and other interested groups intervene with lawful regulations and restrictions as a failure in compliance with environmental policies can lead to product obsolescence. The cost of repeated obsolescence intervention throughout the power plant systems exceed the incremental cost associated with an obsolescence management strategy.

The power industry has no control when a certain manufacturer decides to no longer support or fabricate components identical to the ones installed in power plants. Power Utilities incur unnecessary cost escalation due to plant shutdowns as a result of lack of spares or lack of suitable replacement for an obsolete component.

Many Power Utilities systems are manufactured comparatively in low quantities compared to mass produced items in the commercial world [2]. These systems are often very expensive, built with state of the art technology for their time, and may be used beyond the original lifespan originally predicted. Design lifetimes in military systems are often on the order of 10-20 years, but many systems are now used for 50 years [3] and more. Examples of such systems include Boilers and Turbines systems.

As these systems evolve through their lifecycle, components may be upgraded in order to improve capability or to extend the systems' mission or to compensate for design flaws that only became apparent after extensive use. In addition, components may be required to be replaced because the system lifespan of the component or over time there could be a larger demand than what was expected for a lifetime or the planned manufacturing level for that component. This has resulted in the lack of an effective Power Utility project budget cost over-run, slip project deadlines, and high risk of exhausting Power Utilities funds.

There has been great loss of incomes, loan debts increase, project missing scheduled times, and this has a high probability to jeopardize Power Utilities credit rating .The loss of revenue has a potential to cause Power Utilities financial unsustainability, as money will be wasted on the delayed projects. With no doubt, the demand for electricity in the country has tremendously increased and this therefore calls for reliable supply of electricity to be available hence reliable systems need to be available all the time.

1.2 Problem Statement

Currently, there is a problem in Power Utilities relating to poor management and planning of obsolescence (systems ageing), which affects Power Utility plants in terms of producing electricity supply in time due to obsolete systems. Customers are affected if obsolescence is not planned and addressed in time in plant equipment. Therefore the research seeks to examine the existing Power Utilities methods of addressing and managing obsolescence. It focuses on the challenge of assessing poor ageing management and in addition, it examines some of the gaps in the existing methods and demonstrates some new systematic approaches that can bring improvement relating to ways in which the management and control of equipment ageing process is performed in Power Utilities.

Lack of obsolescence management of plant systems at Power Utilities impacts power plant, and poses challenges in supplying electricity in time to customers. Further, it affects customer satisfaction and company's competitive advantage. The intention of this study is to come up with new approaches to plan, manage and control equipment ageing of Power Utility systems in order to improve the reliability and availability of supply of electricity to customers.

1.3 Purpose of the Research Study

The purpose of this study is to analyse the current ways in which ageing is currently addressed, managed and then look at new optimized strategies that can be developed and followed in order to improve the issue of neglected ageing planning of equipment in Power Utilities. This new optimized systematic approach would be used to reduce the impact that obsolescence has on the availability and reliability of Power Utility equipment.

1.4 Research Objectives

The main objective of the study is; to assess the ability of the existing obsolescence management strategy to support the South African Power Utility business objectives.

This main objective is supported by the following sub-objectives:

1. Identify the method employed by Power Utility to manage asset deterioration.
2. Identify technology management strategy suitable for Power Utility environment.
3. Identify areas of improvement to optimize the impact of asset deterioration.

The aim of this research is to investigate technology management strategies that would be most beneficial to Power Utilities in optimizing the management of obsolescence in Power Utility plants.

1.5 Research Questions

The following research questions were created to achieve the research objectives:

- ❖ What is the approach adopted by Power Utility is South Africa to manage Obsolescence?
- ❖ Does the existing obsolescence management strategy adopted by SA Power Utility support the business objectives?
- ❖ What technology management model would best suit Power Utility environment?
- ❖ Which area of the existing obsolescence management strategy needs to be improved in order to reduce the impact of ageing equipment?

1.6 Significance of the Study

This study will assist Power Utilities in South Africa to improve their planning when addressing the ageing of systems. The research will also:

- ❖ Provide guidance to the senior management, engineering management, maintenance management, operating management in other organisations on how to conduct proper obsolescence management and planning proactively to address the ageing of equipment in time to improve plant availability and reliability.
- ❖ Help to provide methodologies to Power Utilities in optimising methods of addressing ageing proactively.
- ❖ Facilitate and assist in adding knowledge as well for literature to researchers who wish to make reference and cite this study when writing about technology ageing management.

1.7 Limitations of the Study

Time and the availability of resources such as engineering, maintenance and operating, management personnel to respond to questionnaires are considered as the limiting factors for this study.

1.8 Document Overview

The entire report comprises of five (5) chapters.

Chapter 1

In this chapter, the problem statement is introduced and the background of the project is provided.

Chapter 2

Chapter 2 addresses relevant literature related to the ageing of Power Utilities Systems, as well as what approaches and strategies in managing and addressing ageing are presented.

Chapter 3

The Third chapter describes the research approach that has been followed to carry out this study.

Chapter 4

Chapter 4 focuses on presentation and discussion of results.

Chapter 5

The last Chapter finally presents all conclusions and recommendations for the entire study.

1.9 Summary

This chapter provides the background of the problem addressed by the study. The importance of addressing ageing early before the components' end of life is discussed. The aim of this research was to investigate new approaches and strategies that could be used to manage ageing of equipment in South African Power Utilities.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A literature review is given on the subject under analysis “Obsolescence management the study of Power Utility in South Africa”. The chapter begins by discussing challenges resulting from lack of managing technology obsolescence in power utilities. Strategies that are currently used to address, plan and manage ageing challenges and their shortfalls are also discussed.

Although the focus of the research is on optimizing technology obsolescence management, it cannot be looked at in isolation without considering operating equipment, technology continuous improvement, plant maintenance styles, quality and costing. Therefore, in order to ensure that all important aspects are considered when selecting new methods that can be adopted to optimize the planning and management of Power Utility ageing, an in-depth study of existing methods is carried out in this chapter as well as a review relating to what the other authors are saying about the topic of obsolescence management.

The chapter further discusses factors that have to be considered when managing equipment ageing, the relationship between operating and maintenance of components on systems versus the life cycle management of assets. The chapter further presents a discussion around the effective methods of mitigating ageing.

2.2 Obsolescence Management Theory

2.2.1 Component Obsolescence Management

Obsolescence means a component that is no longer available from its Original Equipment Manufacturer [1, 3, 4]. They also indicate that obsolescence affects all systems throughout the total life cycle of a component and is not restricted to hardware systems; it also affects software, standards and specifications. It is evident from literature that obsolescence is costly to correct at later stages of component lifecycle [2, 5] and it affects a lot in power utilities, therefore obsolescence management planning and mitigation methods are to be implemented during the initial design stages and at the beginning of the life cycle of an asset until its end of life.

Sanborn and Colleagues [7] are recommending a model called **"Obsolescence Mitigation Timeline"** which classifies obsolescence mitigations ranges to implement as the system component migrates over different obsolescence profiles. They even go further in suggesting that Power Utilities must manage obsolescence well in order to contribute in dropping downstream costs, and one vital factor they recommend is that management of obsolescence should be addressed in the early planning phases of engineering designs in order to support plant availability and reliability.

2.2.2 Obsolescence management Planning

There is an agreement amongst scholars [3, 4], that obsolescence needs to be managed in the early stages of the design phases, specifically at the design stages where several plans and strategies to manage obsolescence can be considered. The authors also indicate that design for obsolescence can be managed as events and can be included in an obsolescence management plan, taking into account that not only electronics age, but other aspects such as software and test equipment go through obsolescence phases [10].

[3] proposes **"Obsolescence mitigation and resolution strategies"** which classify what planning needs to be done per phase on the lifecycle of a component .The authors further suggest that the first line is obsolescence is awareness of lifecycle of the systems to be able manage obsolesce forecasting . Illustration of forecasting methods; reactive, proactive, strategic obsolescence management strategies should then be looked at.

2.2.3 Obsolescence risk Assessment

Due to technology advancements, system components end up having reduced lifetime span. This is due to better technologies that are introduced faster in the industries, resulting in obsolete components. The researcher goes on to mention that when it comes to managing obsolescence, pro-activeness is the best approach to retain reliable power utility systems and produce good end results that make customers happy. Terpenny and other scholars [5] are recommending development of a system called **“Obsolescence risk measurement tool”** that assists in managing equipment obsolescence by assessing, predicting, control actively, and mitigate obsolescence. This model includes regression model developed for forecasting obsolescence as well as identifying variables that are critical and are predecessors to a component that is becoming obsolete. These scholars believe that this can assist Power Utilities to be able to perform obsolescence forecasting better.

2.2.4 Obsolescence Mitigation options

“**Obsolescence mitigation analysis and risk rating method”** is what Devereaux and other researchers [6] are advising in order to determine risk of obsolescence in systems. These researchers are mentioning that depending on an assessment of obsolescence risk performed on plant systems the strategy may range from reactive to proactive. They conclude by adding that these mitigation activities are to be used during the phases of life cycle of equipment until the end of life [6].

Obsolescence Mitigation should not be mistaken for Obsolescence Prevention as it is impossible preventing obsolescence entirely in systems that have large complex components [7]. He goes on to say that; obsolescence problem is a challenge specifically in systems that are using hardware or software. This challenge is due to the support of this type of equipment as they are dependent on the seller. Therefore he finally recommends a system called **“Obsolescence Management Plan”** that provides support in obsolescence problem identification, analysis, and resolution. This plan offers a methodical constant approach to assist organisation in inspecting obsolescence throughout lifecycle of an asset and assist in proactive measures to address future obsolescence. By doing all these models, obsolescence would be mitigated in all different stages of a project, from systems engineering, testing, and supply chain.

2.2.5 Influences and drivers of technology obsolescence

There is an agreement amongst scholars [8, 7, 9], that large and costly systems face major issues in terms of obsolescence. Due to faster component development, technology becomes obsolete quicker [9]. The authors went on to point out Obsolescence Management shortfalls in organisations:

- Taking part in Obsolescence Teaming Groups is lacking as well as putting a structure in place to address obsolescence.
- Obsolescence management planning lacks.
- Obsolescence monitoring and control is also lacking.

A “**Proactive planning obsolescence management approach”** was suggested by the scholars as preferred planning management process. The authors state that obsolescence mitigations usually happens after the obsolescence problem occurred at Power utilities, and in many cases it comes as unplanned and unforeseen issue.

2.2.6 Obsolescence monitoring and control

System lifecycles are vital for strategic planning and management of obsolescence. The lifecycle expectations of large power plant systems are significantly longer than most of the critical components that make up the system itself [3]. Therefore, it becomes a concern that components within a system would need to be replaced many times over the lifecycle of a system. He suggests that time spent on prior planning needs to have a strategy broken down to replace the component bit by bit included as part of obsolescence management planning.

The author goes further to mention that these systems are often arranged in various environments. For example, one item might require an upgrade before other systems, which can pose risk to the other systems. He also stresses the fact that little planning is spent on obsolescence costing - more focus is always put on tools to managing the life cycle of a system.

2.2.7 Obsolescence Forecasting

Obsolescence is a component that becomes obsolete when technology is no longer manufactured by its supplier [13]. The author agrees with other scholars, that fast changes in technology advancement, maturity, decline, phase-out and technology stoppage have triggered obsolescence of electronic parts. There is an agreement amongst scholars in literature [3, 11, 12] on the fact that life cycle of numerous electronic components is shorter than the life cycle of the system that they are built in. Therefore this study aims to explore reasons why these components are reaching end-of-life and failing at higher rates in power utility systems. This results in high costs in obsolescence in the whole life cycle of long-field life systems, which need to be managed, mitigated and resolved.

2.2.7.1 Obsolescence Risk Assessment

Obsolescence management is a tool that is used to reduce downstream costing instead of generating saving [10]. The importance of managing obsolescence is vital as it affects systems availability, supportability and maintainability. He goes on to say that Operational Maintenance is another important part which needs to be addressed in system engineering plans to support reliability, maintainability, availability plant requirements. He further notes that a systems engineering and management approach for obsolescence is to treat it as risk.

These researchers are suggesting developed the "**Risk-Based Systems Engineering Assessment Model"** [10] to attempt to minimize the risk of obsolescence systems inclusion throughout the system lifecycle. The model would be used to assess various risks (criticality, complexity, and life-cycle cost) related to equipment systems. The tool is also used to determine when obsolescence should not be planned.

2.2.8 Process for Addressing Obsolescence

The emphasis associated with methodology, tool and "**database development**" targeted at the management of electronic part obsolescence, has been focused on accurately tracking and managing the availability of parts, forecasting the risk of parts becoming obsolete, and enabling the application of mitigation approaches when parts do become obsolete. In addition, the majority of the funding in the obsolescence area is focused on minimizing the cost of obsolescence mitigation which is a huge risk [11]. While there is unquestionable merit in devoting resources in optimizing the reactive management of obsolescence, it does cost a lot ultimately much savings can be made, whereas methods targeted are pro-active and life cycle planning of systems could be successfully developed and applied.

2.2.9 Technology management models

Strategic proactive obsolescence management model called "**Mathematical obsolescence management model**' 'is what is introduced by [11]. This model can be used to assist to find obsolescence management schedule for minimum cost. The model gives guidance to designers on how to control the obsolescence management costing. The model presented utilizes redesign and last-time-buy as two monitoring methods. The last-time-buy cost is estimated by unit cost, demand quantities, discount rate, and holding cost. Redesign cost is associated with component type and quantities. This model can estimate the minimum obsolescence management costs for a system with different designs. It consists of two steps, the first is to generate a graph, in the form of an obsolescence management diagram. A segments table containing the data of this diagram is calculated and prepared for optimization at a second step. A reactive manner is presented as a comparison. The result of the strategic proactive management model shows significant cost avoidance as compared to the reactive manner.

2.2.9.1 Proactive Obsolescence Management System

Defence and Commercial Original Equipment Manufacturers are currently facing the risks of system obsolescence affecting stability of their systems. Irrespective of the interval of their systems lifecycle, OEMs have measures in place of obsolescence management to lessen the risks associated with ageing components as well as its costing [18]. Defence, aerospace and commercial OEMs are known to have obsolescence strategy that is well managed. Compared to those with smaller end products, they rely solely on reactive approach measures [20]. He goes on to say that the goal of an ageing management programme should be to ensure the availability of all required safety functions throughout the Power Utility, taking into account the changes that occur with time and use. He concludes to say that ageing management needs to be planned mainly with safety principles in mind, not during only operating phase of a plant but from the first basic design phase [9, 19].

2.2.9.2 Reactive obsolescence management

Typically, systems engineering is a front-end activity for a project that peaks early in the project life-cycle and then reduces in activity level as the project moves into development. Systems engineering is also important during the integration and test phases and then finally tapers down after system deployment. Obsolescence mitigation can be proactive or reactive, but in either case, to fully leverage a mitigation opportunity, a system engineering approach should be used [12].

2.2.9.3 Preventative Obsolescence management

Proposal for establishment of an "**obsolescence team"** that includes members from engineering, procurement, design engineering, project management, manufacturing and program management is what is suggested by [21]. This team would monitor the state of the system components for obsolescence and when obsolescence is discovered, then it would be packaged into categories.

The author goes on to state that all organisations with good product endure a four-stage life cycle: emergence, growth, maturity, and decline. Technology ages faster allowed by compressed technology cycles and enhanced by new knowledge [9]. Organisations find themselves in a race against obsolescence due to these rates of growth. Technological companies always affect change management practice [5]. The author goes on by giving an example of printer technologies that change with time thereby increasing rate of obsolescence.

2.2.9.4 Obsolescence and product lifecycle

Commercial aerospace manufacturers are depended on well-developed military electronic components and specifications infrastructure to assure long-term availability of components. This was possible because the military market sector comprised the total market designs.

Electronics has grown steadily in importance since the beginning of age. Although electronic components and systems are not the largest cost elements in military or, they are found in almost every system, including those that are primarily mechanical, hydraulic, and pneumatic. The solid state electronics industry has grown in parallel with the industry [7].

2.2.10 Obsolescence management planning

Monitoring the supply chain is an essential part of obsolescence identification [22]. Partnership between supplier, integrator and end-user to mitigate the effects is essential. Reviewing the overall system designs for technology insertion, hardware abstraction and program/product synchronism hold great promise as methodologies for the future.

The researcher identifies that for all of the planning and design that can initially be developed into a system, that coordination with the supply chain is essential in order to gain a coherent obsolescence mitigation approach [13]. This coordination can begin with simply monitoring the supply chain for part availability to more proactive approaches that involve special supplier agreements to incentivize a supplier's support of a particular product line or even acquisition of certain suppliers to ensure that the supply of parts will be ensured for a particular product. These authors are putting forth the proposal for product database, which contains relevant information on products in obsolescence management centre, as well as a method that considers ways to predict when a component may become obsolete based on assessing the ability to source the component.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter outlines the approach implemented for choosing a sample from the population, data collection and tools, methods for data analysis in order to answer the research questions. [25] Defines research methodology as a plan in classifying what and who is considered in the study and how data is collected from a population of concern. The author views research methodology as an activity time based plan intended to answer research questions and deliver path for the study .This chapter describes an approach that was followed when conducting this research. It provides an inclusive explanation of the process that has been used in this study to come to different conclusions. It consists of research design and methodology, Research approach, population and sample, Data collection, Data analysis, data interpretation, Validity and Reliability, Ethical considerations, Honesty, Objectivity, Respect for Intellectual Property, and Conclusion.

3.2 Research Design and Methodology

A research design is an overall plan that narrates the conceptual research problem to the appropriate and practicable realistic research. This means that the research design makes provision of a plan or frame work for data collection and analysis. There are various research design approaches and the most suitable one for a research relies on the preferred starting point of the researcher in relation to present theories. This research study utilised deductive research methods as it sought to deduce a point via qualitative methods of getting opinions from employees at power plants [25].

3.3 Research Approach

A qualitative and quantitative research approach, was adopted for this dissertation; which according to [22] the order that should be followed is data collection, data analysis and, development of theory. It was considered to be a mixed method approach because the aim of this research was to investigate organizational management approach that could be used to optimize obsolescence management in power plants. Data was thus collected through the literature reviews and via questionnaires. Different aspects of the subject were thoroughly evaluated during the literature review process.

3.4 Population and Sample methods

A population refers to all fundamentals that meet the sample criteria to be included in a study [25]. This includes individuals; objects and events. The population of this study comprised all system engineers working on projects, operators, maintenance technicians, planners and management that work for Eskom power plants in order for me to get a broader view on how they were involved in managing obsolescence.

A sample is the representative part of the entire population selected to be analysed during a research [25] . A sample size of 50 participants was taken from the total number of Eskom engineers, operators, procurement and management and 28 employees participated. This conforms to the advice for statistical analysis which states that; the number thirty is a useful rule of thumb when a decision has to be made on appropriate sample size.

3.5 Data Collection

Different methods of data collection instruments exist, these include observation; structured and semi-structured interview, questionnaires, and secondary sources [25]. A questionnaire is “a method of collecting information from respondents about attitude, knowledge, feelings and beliefs”. A questionnaire was used in this study to answer the question “Does Power Utility have efficient obsolescence management strategy in place to ensure effective availability of power plant to customers?” and to determine if there are any other factors that cause the organization not to successfully Implement obsolete systems and equipment in time. The questionnaire utilized both open ended and closed questions. Secondary sources were also obtained from the organization’s website, internet, journals, previous research reports as well as persons with good understanding of Obsolescence Management.

3.5.1 What is the approach adopted by Power Utilities is South Africa to manage Obsolescence?

The above question was answered by triangulating literature sources and the questions from the survey respondents.

3.5.2 Does the existing obsolescence management strategy adopted by South African Power Utility support the business objectives?

This question was the core of the study. To answer this question, the researcher reviewed literature and selected eight key success factors required for the effective obsolescence management strategy. The eight key success factors were then stated as statements in the Likert scale [18] for the participants to rate the level of agreement and disagreement with the statement. The participants were asked to select from strongly disagree, disagree, neutral, agree, and strongly disagree.

The survey which consisted of three sections was distributed to fifty (50) Power Utility employees, who were working within the asset management environment. The requirements for the survey participants to participate in this study included the access to computer with e-mails, and practice within the asset management environment. The reason for selecting the asset management department as the area of study included the level of knowledge of the employees in the subject and their exposure on the phenomenon under investigation.

This question was further answered through the use of statistical model which included the Chi-square test, Pearson Correlation analysis and descriptive statistical analysis. The Chi-square was resourceful in testing the perception of the Power Utility employees on the quality of the obsolescence management strategy. To test the hypothesis the author formulated the two claims, as stated below.

Null hypothesis (H_0): The existing obsolescence management strategy supports the South African Power Utility business objectives.

Alternative hypothesis (H_1): The existing obsolescence management strategy does not support the South African Power Utility business objectives.

The process of performing the Chi square test included:

- Restating the above hypothesis.
- Selecting the level of significant.
- Calculating the Degree of Freedom using the formula.

Equation 1

DF= $(Row - 1)(Columns - 1)$

DF = Degree of freedom

Row = Number of rows

Columns= number of columns

- Finding the critical value from the Chi Square chart
- Derive Expected values from the observed values using Minitab statistical software
- Test the statistic (Chi Square test) for agreed and disagreed values
- And finally draw the conclusion

3.5.3 What technology management model will best suit Power Utility environment? (Look at different types of models via literature)

To answer this question the researcher conducted an extensive literature review on technology management [19]. Technology Management Models are Systems-Engineering Approach to Technology Development programs. [22] Support the evolution of developing and mature technologies to customers. These models are helpful in knowing when management of transition needs to happen.

3.5.4 Which area of the existing obsolescence management strategy needs to be improved in order to reduce the impact of ageing equipment?

To answer this question, the researcher used the survey results from the respondents.

3.6 Data Analysis and Interpretation/Unit of analysis

The analysis of data in a qualitative research is done from the time in which it is collected. This approach enhances the reliability of the data. This is in accordance to [22] who maintains that *"Data collection and analysis is a simultaneous activity in qualitative research. Analysis begins with the first interview, the first observation, the first document read."*

In this way, the researcher was given an opportunity to evaluate data immediately, thus making it possible for the researcher to make adjustments along the way, even to the point of changing the method of data collection. In this approach; testing of emerging concepts, themes and emerging categories against subsequent data is allowed. This is the approach that was adopted in this study.

Qualitative analysis offers an opportunity to the researcher to demonstrate that the conclusions to be reached are derived from the data generated in the study. Analysing data is the heart of constructing theory in case study research, thus the theory would be built from data that has been analysed through a recognised process.

The data analysis process used for this study included data reduction, data display, as well as conclusion drawing. The data analysis process aims at organizing data logically, categorizing it into meaningful groups, making data interpretation through inspections, seeking themes, patterns, meaning and to eventually come up with generalizations that might require further studies of a phenomenon.

3.7 Data Reduction

Data reduction is the process of choosing and simplifying, extracting and transforming the data appearing in written up notes [22]. Even prior to actually gathering the data, data reduction is taking place as the researcher makes decisions as to which research questions and data collection methods to select. Data reduction is a form of analysis which sorts, focuses, removes and organizes data in a manner that makes it possible for conclusions to be drawn and verified [25]. During and after gathering of data, a process of data reduction was applied in this study.

3.8 Data Display

A display is an organized, compressed gathering of data that allows a conclusion and action to be drawn [22] . Data display serves to prevent data overload during data analysis, makes it possible to view and enhance data more clearly for the study and to make sense of data that has been gathered by the display of related concepts from different statements [25].

3.9 Data Conclusion Drawing

Qualitative analysis is a method of transforming data into something that does not exist as a means to obtain a fresh view of the data from the population. Data is broken down as a way to classify it, and the concepts created in organising data, and the connections made between these concepts, makes provision for the basis for the new description. This involves going back taking into consideration the meaning of the analysed data and to make assessment of their implications for the question at hand [25].

Verification, integrally linked to conclusion drawing involves visiting the data again for as many times as required as a way to verify these developing conclusions. The meanings evolving from the data are tested for their legitimacy. In this case; validity covers a much broader concern for whether the drawn conclusions from the data are credible, warranted and if they have the ability to withstand alternative explanations [22].

3.10 Data Interpretation

Interpretation of data included personal perspectives of the researcher. This is in accordance to [22], who argued that *"Qualitative research is a highly personal research".* Repetition of certain words from the data that has been collected shows that respondents have a strong feeling about these issues. A pattern is described in terms of matching the predicted outcome by the repetition of words in the collected data, which then emphasizes the internal validity.

3.11 Data Validity and Reliability

Reliability can be defined as “degree of uniformity with which an instrument measures the attribute it is designed to measure” [22]. Further; repetition of certain statements from the data that has been collected via questionnaires shows those respondents had a strong feeling about these issues.

Validity “determines whether the research truly measures that which it was intended to measure [25]. As a means to evaluate the validity of information from one source, there has to be other sources that give the same information. Articles and journals are peer reviewed. The data collected from questionnaires at Eskom was validated by an Eskom employee who was in the environment and was able to use common sense to check the validity of the generated data.

Data from questionnaires was split in three categories, which were engineers located at power stations, engineers located at offices as well as looking at overall results which would be a combination of the engineers located on site and offices, operators, planners, management and procurement. If the results are consistent in all these groups, then it would be an indication that the questionnaire measured what it was supposed to measure and allowed the researcher to generalize the results across the entire population. The researcher would also validate the final research results against previous research as discussed in the literature review.

3.12 Honesty and Objectivity

The researcher was authentic when doing data reporting, presenting results, methods and procedures. Data was not fabricated, falsified, or misinterpreted. Bias in data analysis, interpretation and all other aspects that require objectivity was avoided by the researcher. In cases where conflict of interest could affect the research, this has been disclosed.

3.13 Respect for Intellectual Property

Ideas from different authors were used in this project. These authors’ intellectual properties were acknowledged by referencing them within text and at the end of the report. No unpublished data, methods were presented in this study without permission.

3.14 Conclusion

A qualitative and quantitative inductive research approach was adopted in this study and was briefly discussed. The adopted research approach is Hermand [22] methodology. Its principles include data collection, data reduction, data display and conclusion drawing. Survey questionnaires were chosen as the primary source of information. The next chapter looks at applying these principles to the Power Utility Plants to determine how management of obsolescence could be effectively implemented to achieve its business strategic objectives.

CHAPTER 4: RESEARCH RESULTS, FINDINGS AND DISCUSSIONS

4.1 Introduction

The main purpose of this chapter is to present the results from data collection which helps me to answer the research questions. Both qualitative and quantitate research methods were adopted in this study. The online survey questionnaires were distributed to 50 participants who formed part of the sample and only 28 respondents completed the questionnaires. The other sort of information required to answer the research questions was collected from the Power Utility asset management system. Data is presented in the form of charts, graphs and tables.

The survey consisted of four sections; section A, B, C and D. Section A consisted of demographic information, section B consisted of the Likert scale items and section C had open ended questions focusing on soliciting opinions from the respondents and section D consisted of statistics from asset management systems. The Likert items were constructed to collect opinions on the quality of the existing power obsolescence management systems. In section C, respondents were asked open ended questions on their views relating to what they think were problems regarding the current obsolescence management system. The last part of this section presents the failure analysis from the asset management system from 2014 to 2016.

4.2 Section A

Section A consisted of five questions which were designed to gather information and characteristics of the respondents. Although the researcher was not aiming at finding characteristics of the respondents, they were useful in the validation and reliability of the study.

4.2.1 How long have you been exposed to asset management line of work?

The main purpose of this question was to find out whether the respondents had enough knowledge and understanding of the subject.

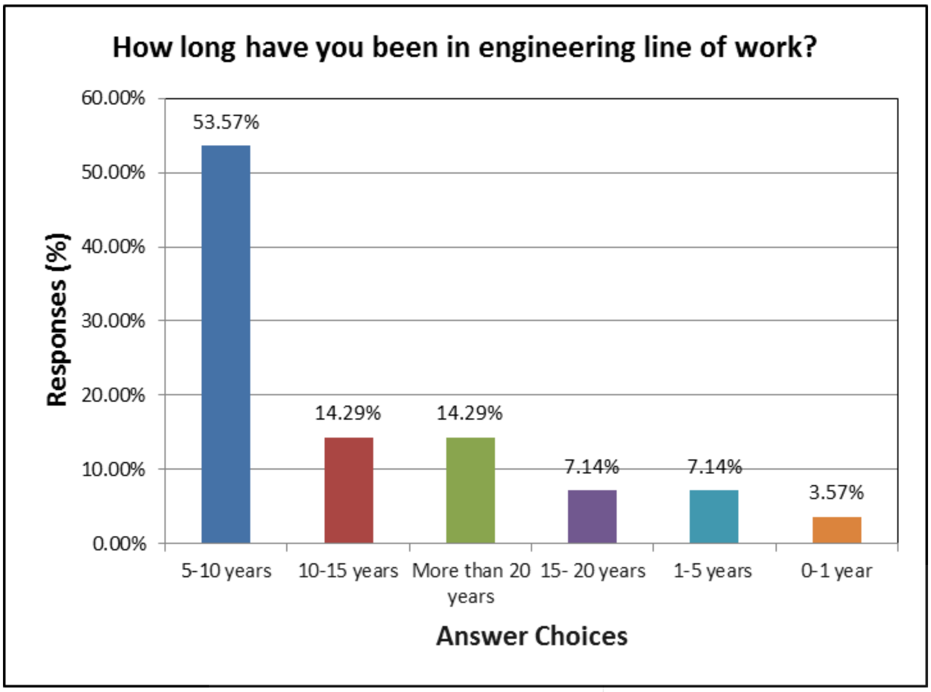

Figure 1 : Asset Management Work Experience

There were 28 people who responded to this question and the majority (53.57%) had work experience ranging from 5 – 10 years in the asset management environment. The other majority (35, 72%) had the experience ranging from 15 to more than 20 years. The remaining 11.2 % years of experience had experience of 0 to 5years. These figures show that people who participated in the study had sufficient knowledge and understanding of the subject.

4.2.2 How would you describe your level of responsibilities?

This question was asked in order to establish the level of responsibility and accountability of the respondents.

Table 1: How would you describe your level of responsibilities?

Answer Choices	Responses	Responses (%)
Engineer	7	39%
Senior Engineer	5	28%
Engineering Manager	3	17%
Chief Engineer	1	6%

Other	1	6%
Senior Technologist	1	6%
Artisan	0	0%
Engineering Technician	0	0%
Principal Engineer	0	0%
Technologist	0	0%
TOTAL	**18**	**100%**

Of the 28 people who responded to the survey only 18 people answered this question. This indicates that some people were not comfortable with the idea of disclosing their level of responsibility. However, the majority (39%) of people who responded held the title or the responsibility of an engineer. The other 28% classified themselves as senior engineers. The engineering managers only accounted for 17% of the respondents. The other group which included chief engineers, senior technologist and others accounted for 6% each. This means that engineering line of work is highly affected by obsolescence management and this might have created the desire for engineers to participate in this study. Furthermore, the amount of engineers and senior engineers who participated in this study were confident that the study results reflected the true obsolescence management practice in the Power Utility South Africa.

4.2.3 Which of the following best describes the field in which you received your highest educational qualification?

Since the survey was distributed to everybody working in assent management in the Power Utility, it was important to classify the educational background of participants in the survey.

Table 2 : Which of the following best describes the field in which you received your highest educational qualification?

Answer Choices	Responses	Responses (%)
Business	0	0%
Computing	0	0%
Engineering	18	100%
Healthcare	0	0%
Mathematics	0	0%
Medicine	0	0%
Other (please specify)		0%
Science	0	0%
Technology	0	0%
TOTAL	**18**	**100**

Of the 28 respondents who participated in the survey, only 18 people answered this question. All the participants received their highest qualification in engineering. This is in line with the results in table 2 which indicates that engineers are highly affected by obsolescence management.

4.2.4 Which of the following best describes your highest educational qualification?

This question was aimed at establishing the level of education of the respondents.

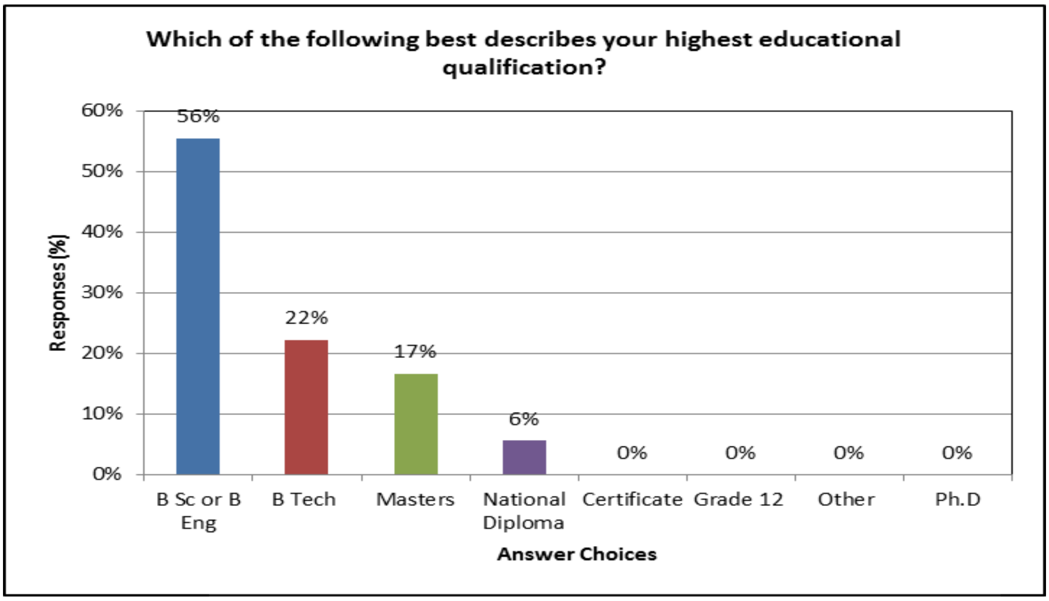

Figure 2 : Highest Education Qualification

Figure 5 represents the educational qualifications ranging from highest to the smallest. The majority of the respondents had Bachelor of Science and Bachelor of engineering Degrees. Of the 28 respondents who participated in the survey, only 17 people answered this question. Of the 17 respondents, the majority (56%) had Bachelor of Science and bachelor of Engineering Degrees. While other 22% had the bachelor degrees from comprehensive Universities, the other percentage of respondents had Maters Degree (17%) and the other had National Diploma (6%). This indicates that the people who participated in this survey had good theatrical understanding of the subject which would help them make informed decisions.

4.2.5 How would you describe your age group?

This question was asked as part of establishing the level of maturity of the respondents in line with the other questions in section A.

Table 3 : How would you describe your age group?

Answer Choices	Responses	Responses (%)
30-35 years	9	50%
35 - 40 years	3	17%
45 - 50 years	2	11%
25-30 years	2	11%

More than 50 years	1	6%
40-45 years	1	6%
20-25 years	0	0%
15- 20 years	0	0%
TOTAL	**18**	**100%**

Of the 28 respondents who participated in the survey, only 18 people answered this question. The majority of the respondents (50%) could be classified as youth whose ages fell within the age group of 30-35 years. The next age group accounted for 17% of respondents which were between the age group of 35-40 years - these respondents were experienced participants in Power Utilities. There was an equal number of 11% of groups who participated in the study within the age group of 25-30 and 45-50 years, a further equal number of 6% falling within the group of 40 to more than fifty years. In general, people who participated in this study had good level of education; they were mature in terms of their age and knowledgeable in terms of their levels of education.

4.3 Section B

4.3.1 Introduction

Section B was aimed at gathering information relating to perceptions from Power Utilities' employees regarding the quality of obsolescence management strategy. The researcher used the hypothesis; 'the power utility has a good obsolescence management strategy'. To test this hypothesis, the researcher used the Likert scale [27] which consisted of 8 elements. The respondents were asked to rate the items from strongly Disagree, Disagree, Strongly Agree, Agree and Neutral, on the Likert scale. The internal consistency of the items was tested using the Pearson Correlation [27] and the Cronbach Alpha. Cronbach Alpha was developed by Lee Cronbach to offer a measure of internal consistency of a scale or test. It is expressed as number between 0 and 1. Internal consistency describes the extent to which all the items in a test measure the same concept construct. A maximum alpha value of 0.90 has been recommended [27]. The Hypothesis was tested using the Chi-Square Statistic analysis. The subsequent section presents the results of the tests

4.3.2 Pearson Correlation

Table 4: Pearson Correlation Matrix

Pearson Correlation Matrix								
	Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*
Q1	1							
Q2	0.75	1.00						
Q3	0.64	0.15	1.00					
Q4	-0.09	0.56	-0.68	1.00				
Q5	0.66	0.95	0.18	0.49	1.00			
Q6	0.51	0.89	0.04	0.56	0.98	1.00		
Q7	0.78	0.98	0.15	0.48	0.95	0.89	1.00	
Q8	0.37	0.82	-0.05	0.61	0.94	0.99	0.81	1.00

The table above shows the relationship among the 8 items of the Likert scale. The majority of the items show a positive relationship except Q3 and Q1 which indicate the negative relationship with Q4 and Q8. This implies that putting an effort in Q3 would not influence Q4 and Q8. Despite the negative relationship from the table above, the scale had a total internal consistency or Cronbach alpha of 0.83 which was higher than 0.70 recommended in the literature. A maximum alpha value of 0.90 had been recommended [27]. To improve the internal consistency, the literature recommends the removal or exclusion of the negative relationship as indicated in table 3 below.

Table 5 : Modified Pearson Correlation Matrix

Modified **Pearson Correlation Matrix**						
	Q2	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*
Q2	1					
Q4	0.55576	1				
Q5	0.946602	0.486408	1			

Q6	0.888944	0.563009	0.981014	1		
Q7	0.982141	0.483456	0.946863	0.889189	1	
Q8	0.820675	0.606658	0.940982	0.988243	0.813985	1

The table above indicates the correlation after removing the negative relationship from the items Q1 and Q3. By removing the two items, the researcher improved the internal consistency from 0.84 to 0.93.

The table above indicates the item correlation after removing the negative relation caused by the two item (Q1 and Q3). By removing the two items, the scale internal consistence increased to 0.93. The increase in the internal consistence agrees with other findings in literature suggesting that by removing the negative relationship you are basically improving the internal consistence of the scales.

4.3.3 Hypothesis Testing

Step 1: State the Hypothesis

Null hypothesis (H_0): The existing obsolescence management strategy supports the South African Power Utility business objectives.

Alternative hypothesis (H_1): The existing obsolescence management strategy does not support the South African Power Utility business objectives.

Step 2: Select a level of significance (α) and Degree of Free (Df) calculations

From Minitab statistic software, the level of significance was selected to be $\alpha = 0.05$, and from the calculations the Degree of Freedom was found to be $Df = 7$. The Chi square distribution for this study is indicated in the figure below.

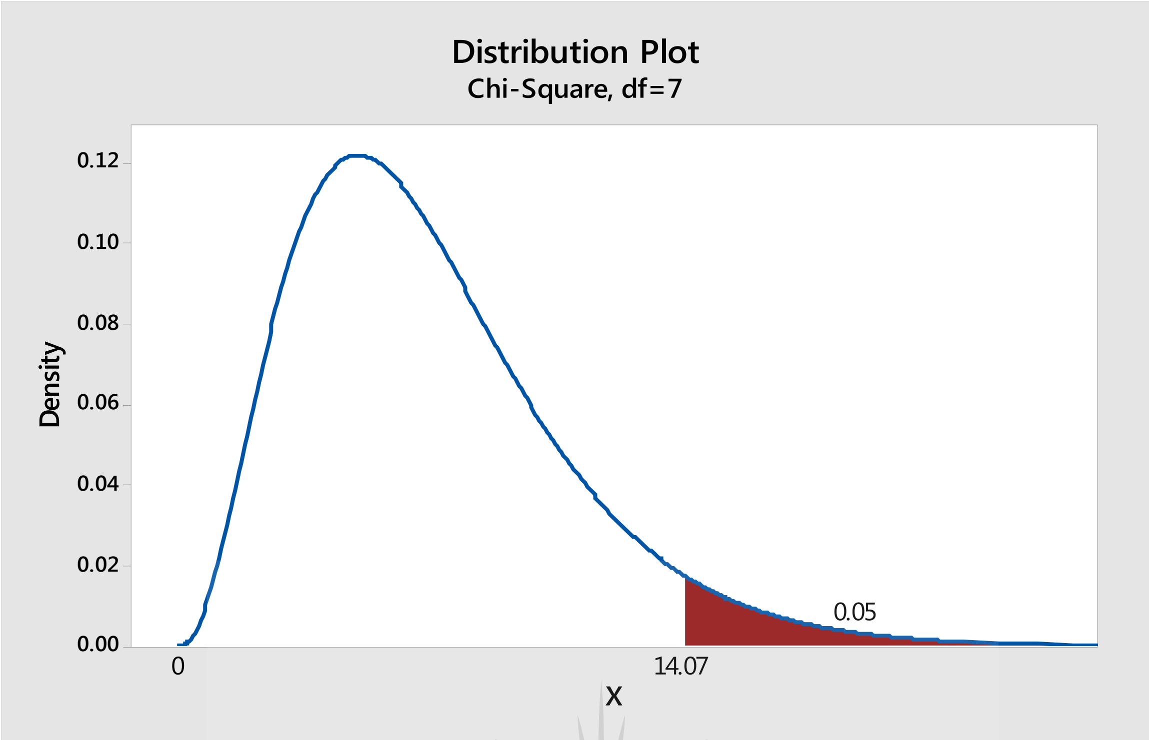

Figure 3: Chi Squared Distribution

Step 3: Derive Expected values from the observed values

Table 6 below indicates the observed values for disagreement with the Likert scale items and agreements. The scale consisted of strongly disagree, disagree, neutral, agree and strongly agree. For the purpose of the hypothesis test, the strongly disagree and disagree were combined together as indicated in table 6 below. The author also combined ‘agree’ and ‘strongly agree’ into one agreed values as indicated below. The neutral was not included in the calculation.

Table 6: Chi Square (X2) Test Observed Values

Observed Values									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	**Total**
DISAGREE	11	7	17	1	7	6	6	6	**61**
AGREE	4	6	0	11	4	4	5	5	**39**
Totals	15	13	17	12	11	10	11	11	**100**

As indicated in table 6 the scale had a total of 61 disagreements and 39 agreements with the Likert scale items. Q1 had the total of 15 people who selected 11 disagree and 4 who selected agree. In the above table 5, disagreement with the Likert scale was dominating except Q4 where the majority (11) of the people selected agreement with the Likert items.

Table 6: Chi Square (X2) Expected Values

Expected									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	**Total**
DISAGREE	9.15	7.93	10.37	7.32	6.71	6.1	6.71	6.71	
AGREE	5.85	5.07	6.63	4.68	4.29	3.9	4.29	4.29	

The table above shows the expected value derived from the observed values in table 6 and the values in table 7 were calculated using Minitab Statically software. The above figures are critical in the calculation of Chi-square (X^2).

Table 7: Chi Square (X^2)statistical test

DISAGREE Chi Square	0.37	0.11	4.24	5.46	0.01	0.00	0.08	0.08	
AGREE Chi Square	0.59	0.17	6.63	8.53	0.02	0.00	0.12	0.12	
Total (Chi Square)	**0.96**	**0.28**	**10.87**	**13.99**	**0.03**	**0.00**	**0.19**	**0.19**	**26.52**

The values from table 8 above were derived from the formula

Equation 2

$$X^2 = \sum \frac{(O-E)^2}{E}$$

X^2 = Chi Square Value

O = Observed values

E = expected values

And the X^2 *=26.52>Critical Value=14.067*

Based on the calculation, the Chi square value falls in the rejection region or it is greater than the critical value. If the Chi square is greater than the critical value, the null hypothesis is rejected and the alternative hypothesis is accepted.

4.3.4 Areas of improvement on the existing obsolescence management

Table 8: Areas of Improvement

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
		1	2	3	4	5	
There is independent team responsible for obsolescence management.	Q1	1 5%	10 53%	4 21%	3 16%	1 5%	19 100 %
There is a separate policy for Obsolescence management.	Q2	1 5%	6 32%	6 32%	5 26%	1 5%	19 100 %
There are regular workshops to create awareness about the role of obsolescence management processes.	Q3	7 37%	10 53%	2 11%	0 0%	0 0%	19 100 %
The obsolescence management for part of the asset management strategy.	Q4	0 0%	1 5%	7 37%	9 47%	2 11%	19 100 %
The current obsolescence management strategy supports the business objectives.	Q5	1 5%	6 32%	8 42%	4 21%	0 0%	19 100 %
Senior Management fully supports the current obsolescence management practice.	Q6	1 5%	5 26%	9 47%	4 21%	0 0%	19 100 %

Obsolescence procedures are easy to understand.	Q7	0 0%	6 35%	6 35%	4 24%	1 6%	17 100 %
Obsolescence documents are easy to understand.	Q8	2 11%	4 21%	8 42%	4 21%	1 5%	19 100 %

Table 8 above is designed to identify the areas of improvement of effective obsolescence management strategy. The survey respondents were requested to rate the items from the table above from Strongly Agree, Agree, Strongly Disagree, Disagree and neutral.

The majority of respondents (58%) rejected the claim that there was an independent team responsible for obsolescence management. Furthermore the respondents also rejected the existence of the separate policy for obsolescence management. The other issue identified from the respondents was the absence of the awareness of obsolescence management which was demonstrated by (90%) of the respondents rejecting the awareness sessions. On the other hand there was a strong agreement (58%) that the obsolescence management formed part of the organisational strategy, although the majority of the respondents indicated that the strategy did not support the business objectives

73% of respondents indicated that senior management did support obsolescence management practice but were not involved. From the literature it was noted that for obsolescence management to be successful you need to have an independent team responsible for obsolescence management. And there is an agreement from literature that separate policies that guide how obsolescence is controlled, to be identified and managed.

The results show that 64% of the respondents disagreed that there was no awareness in place for obsolescence in the organisations. About 90% of respondents were totally in disagreement about existence of documents and procedures in place.

4.3.4.1 General Comments from the Survey

As part of the survey, the respondents were asked to suggest the areas of improvement from the way obsolescence management was managed. Results are shown in figure 5.

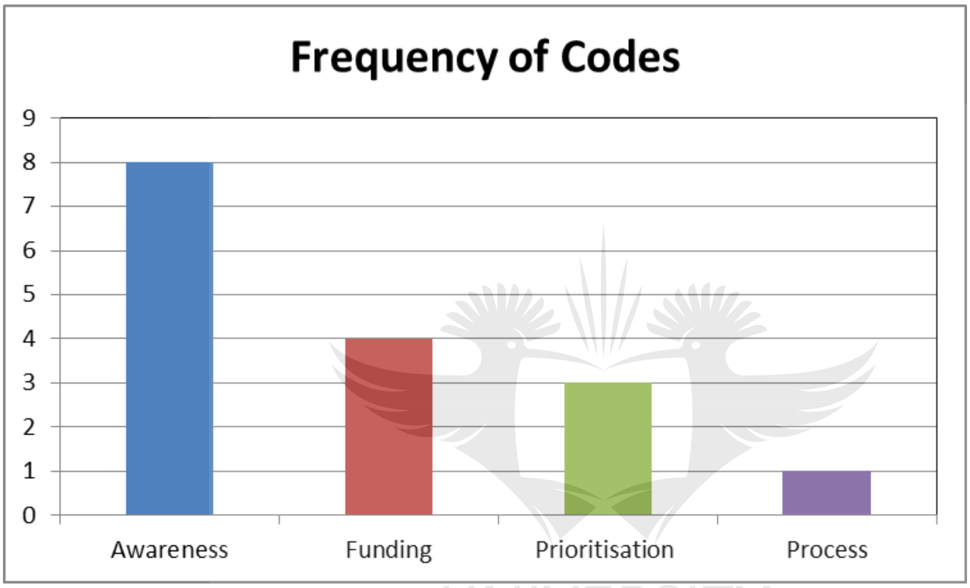

Figure 4: Frequency of Codes on general comments

As shown in figure 5 above, the discussions from general comments were lack of awareness about obsolescence management in the organisation. From the discussions, the lack of awareness appeared more frequently from the respondents. The respondents' opinions were that no awareness about obsolescence management was made in Power Utility employees .The other frequent concern that came through more often from the discussions was the lack of funding allocated to perform obsolescence management. No budget was put aside to fund obsolescence management. The respondents also pointed out the lack of prioritisation of obsolescence management within the Power Utilities. The processes were also mentioned as one of the areas of improvement, no proper processes and procedures were in place to be able to manage obsolescence properly.

4.3.4.2 General ideas from Surveys on areas of development for effective obsolescence management

The last part of the survey was focused on asking the respondents what they thought could be done in order to improve obsolescence management in Power Utilities.

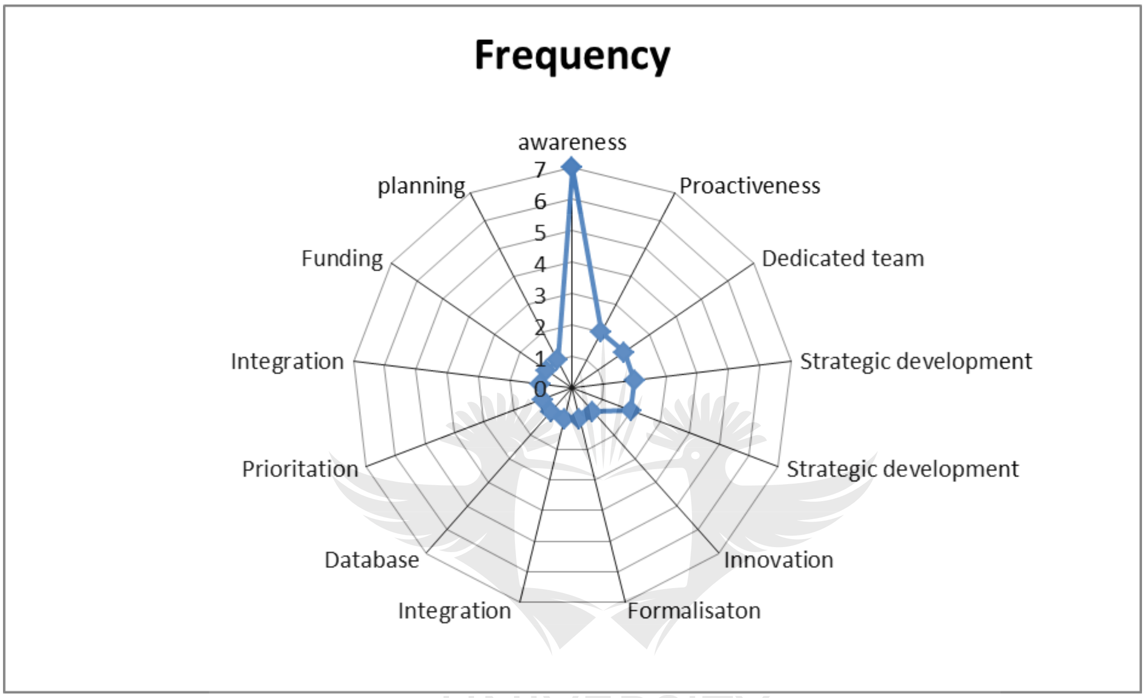

Figure 5: Frequency on what can be done to optimise

As shown in figure 6 above the discussions from opinions of respondents about what can be done to improve obsolescence management, what came out more in their discussions was awareness for Power Utilities to spend more time in performing and developing awareness and developing processes to be in place in Power Utilities. The respondents further pointed out that there was no process in place as well as awareness about obsolescence management in Power Utility employees. This was followed by lack of funding, implying the need for the Power Utility to set budget aside.

What came through from the discussions of what could be done is the optimisation of innovative ways to improve the current systems. Aligning with business objectives was suggested as a key element by respondents to perform obsolescence management. Training was another factor that came through to be developed more.

The respondents also pointed out the lack of prioritisation of obsolescence management within the Power Utilities. The processes were also mentioned as one of the areas to work on, suggesting that putting in place proper processes and procedures would help to manage obsolescence properly.

4.3.5 Power Utility Statistics from asset management systems

This section presents failure history patterns of Power Utility systems from the asset management system from year 2014 to 2016.

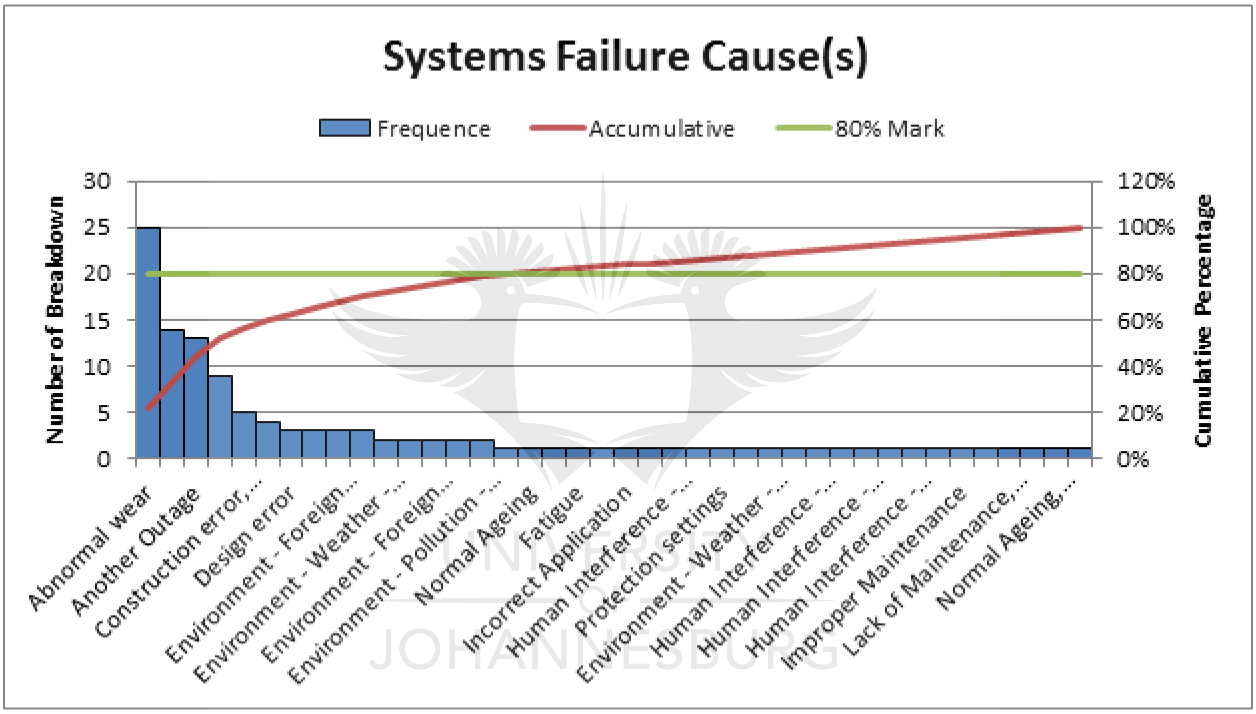

Figure 6: System Failure Causes

Figure 7 above projects the frequency of failures from the past years from the Power Utility systems [29]. X axis projects number of breakdowns and Y axis shows percentage of failures over the years. The graph presents what was the cause of those failures during the last 3 years for the Power Utility. The power Utility experienced 124 failures in the last 3 years. The highest risk of failures was due to abnormal wear and tear, error on designs, construction errors, environmental failures, human interference, lack of maintenance and ageing. Therefore it is clear that during the years (2014-2016), the breakdowns and causes of failures were due to a number of factors relating to wear and tear. Ageing was also one of the causes of failures.

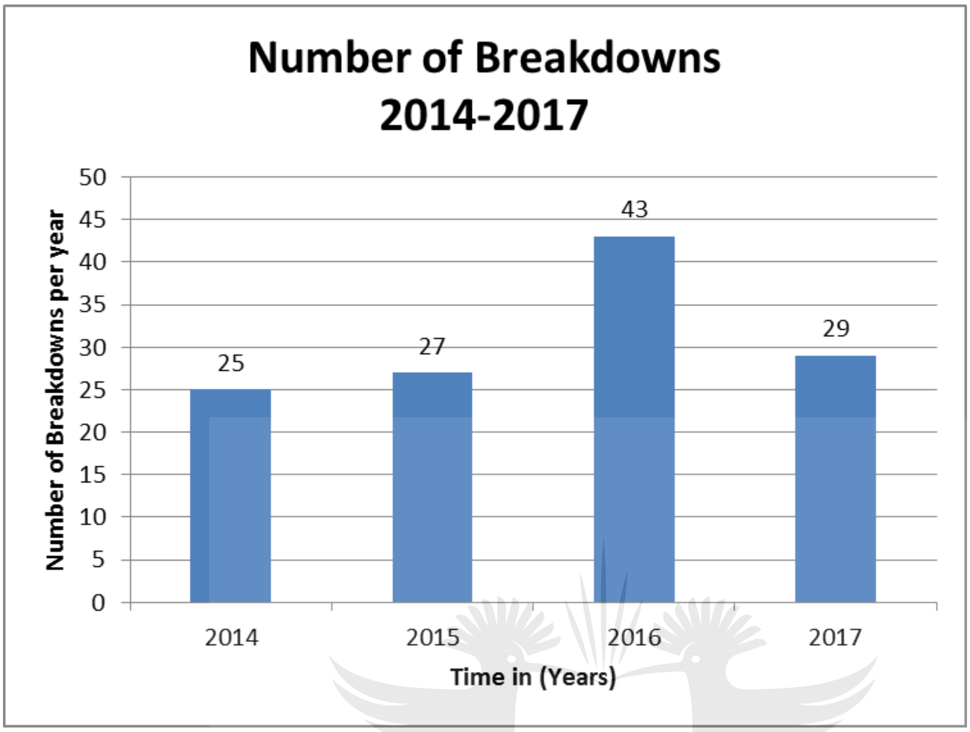

Figure 7: Number of Breakdowns – (X-axis number of breakdowns in %, Y-axis number of years

Figure 8 projects the frequency of breakdowns from the past 3 years from the Power Utility systems. X axis projects number of breakdowns (%) of failures five years and Y axis projects numbers of years. The graph represents the highest rate of failures at 29% in 2016, followed by year 2015 where failures were around 18%. In 2014, 17% of failures were recorded with the lowest percentage of 15% in 2017, and as projected 20% would be expected end of 2017. Total numbers of 124 failures were experienced over the last 3 years by power utility.

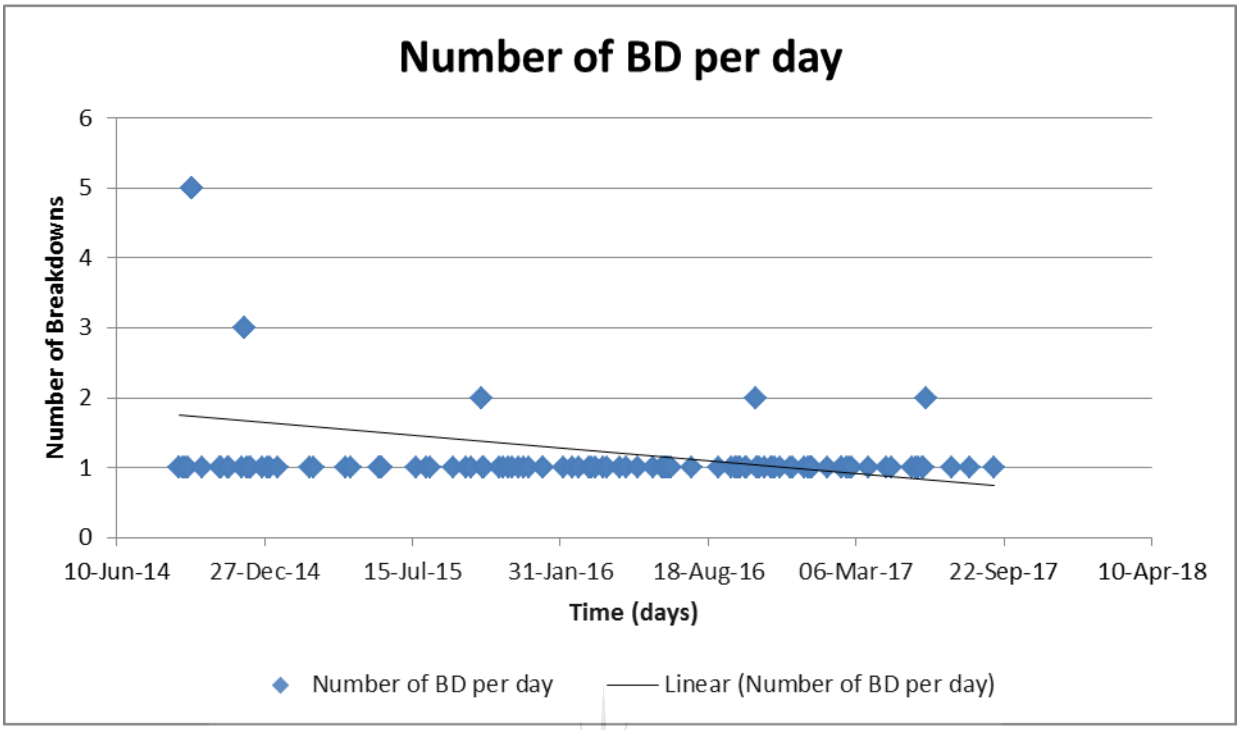

Figure 8: Number of breakdowns per day

Figure 8 shows a projection of breakdown of failures per day, as from June 2014 - December 2014 the failures were close to two breakdowns in those months of that year. In July 2015 the breakdowns came down a bit, but from January 2016- August 2016 there was also a slight improvement of breakdown as indicated on the graph. Between March 2017 and September 2017, there was a drastic improvement. Therefore, from the graph, the highest breakdowns were happening in year 2014.

The organisation appears to be experiencing these failures in the last 5years. Although these failures were recorded during this period, continuous maintenance on the power plants was still happening and most of the equipment was working well. Despite the observable trend of failures, the above graph shows a gradual decrease in failures.

CONCLUSION OF RESULTS

Of the 21 responses, 80% of the respondents answered this question, whereas the other 20% did not provide their responses. Qualitative data analysis method was used to analyse this open-ended question. The next chapter provides conclusions and recommendations for the study.

CHAPTER 5: CONCLUSIONS AND RECOMANDATIONS

5.1 Discussions

The purpose of this chapter is to integrate the research objectives, the literature and the research results and draw the conclusions. This research was aimed at investigating technology management strategies that could be used in assisting Power Utilities in optimizing planning and management of obsolescence. The study was conducted to achieve the research objectives specified at the beginning of this document (chapter 1). It was targeting at finding the gaps that could be improved on the obsolescence strategy, analyse how ageing was planned and managed. Furthermore, the study looked at strategies and approaches that could be adopted to improve obsolescence planning and management within Power Utilities. The obsolescence management strategy should be able to reduce the impact of obsolescence on the equipment plant availability and reliability in Power Utilities.

The study utilised both primary data from survey questionnaires and secondary data from asset management system from Power Utilities. The survey consisted of 5 sections aimed at identifying the characteristics of the participants, concepts of obsolescence management within the Power Utilities and the factors affecting the obsolescence management practice. The secondary data was collected and analysed with the aim of identifying the dominating root cause of the plant/equipment failures within the Power Utilities. The subsequent section aligned the study results to the research questions and the literature review.

5.1.1 What are the methods employed by Power Utilities to manage asset deterioration?

This question sought to explore the types of strategies adopted by Power Utilities to manage obsolescence. This question was answered mainly by matching the results of the survey with the literature review.

The Literature provided a wide range of strategies that could be used to manage obsolescence. These strategies included the following:

- ✓ **Obsolescence Mitigation Timelines** is a model that is used to mitigate risks, applied in identifying ways to mitigate and implement as component or system migrates over different risk obsolescence profiles. This model starts with components with no obsolescence risks and progressing over time to where obsolete parts are being identified. Mitigation strategies will be done on receipt of obsolescence notice. When component is obsolete, mitigation approach will be decided on and strategies and budgeting will be compared in determining best short-term solution to resolve [18]

- ✓ **Obsolescence risk measurement tool** is an Obsolescence risk measurement tool used to forecast obsolescence and is applied to predict and manage obsolescence to assist in managing equipment obsolescence. This model is different in that it includes identifying variables that are critical and are predecessors to a component that is becoming obsolete. [5].

- ✓ **Mathematical strategic proactive obsolescence management model** is a model that can be used in assisting to find obsolescence management schedules for minimum cost. The model gives guidance to designers on how to control the obsolescence management at low costing. It employs redesign and last-time-buy as two management methods. Last but costs is estimated using unit cost, demand quantities, buffer, discount rate, as well as holding cost. Redesign cost is linked with component type and quantities. This model can estimate the minimum management costs for a system with different designs [11].

- ✓ **Obsolescence Management Plan** is a tool that provides support in obsolescence problem identification, analysis, and resolution. This model is characterised by methodical constant approach to assist organisation in inspecting obsolescence throughout lifecycle of an asset and assist in proactive measures to address future obsolescence. [1]

- ✓ **Obsolescence mitigation analysis and risk rating method** which determines risk of obsolescence in systems [6]**.** This mitigation activity is used during the phases of life cycle of equipment until the end of life and is the same model as suggested by [5].

- ✓ **Obsolescence forecasting algorithm** is a model used to define component life cycle in their model. It is used to decrease the life-cycle cost by shaping combination for the design schedule for the system based [29]on calculations of procurement period by using records of previous obsolescence events and introduced parts that have not gone obsolete.

From the survey results the strategy for methods employed by Power Utilities can be classified as reactive approach in nature. People indicated that there was no team responsible for obsolescence management, and there was no awareness about obsolescence concept in Power Utilities. The further indication of the reactive approach at power Utilities can be identified from the statistical results from asset management system, which indicated that the majority of the failures were related to unplanned failures. The general comments from the participants also indicate that there were no awareness sessions and no funding was allocated for obsolescence management.

5.1.2 Does the existing obsolescence management strategy adopted by SA power utility support the business objectives?

The purpose of this question was to identify the relationship between the existing obsolescence management strategy and the corporate strategy in the power Utility Environment. The question was answered through statistical analysis (Chi-Square Hypothesis test). The results of the statistical test indicated that there was a negative relationship or the obsolescence management strategy did not support the corporate strategy. According to Winser and colleagues [29] , there should be a direct link between the corporate strategy and operational strategy to ensure that the organisation achieve its goals, to ensure that the machinery, process, people are aligned with business objectives.

5.1.3 Which areas of the existing obsolescence management strategy that needs to be improved in order to reduce the impact of ageing equipment?

This question was asked to find out if there were areas of existing obsolescence management strategy that could be improved to bring down ageing equipment impact. The results show lack of obsolescence management awareness .The results further show that there was no budget and team allocated for managing obsolescence. Although there were more than three areas of improvement identified from the survey results and opinions of employees, awareness, dedicated team and funding were the most dominating factors.

5.2 Recommendations

The results of the study indicate that the Power Utility adopted reactive approach in managing Obsolescence. The reactive approach does not involve activities like planning and risk assessment, conditioning approach and other planning activities, to ensure that obsolescence management is aligned with business objectives [29]. It is recommended that Power Utilities adopt more proactive approaches to meet its business objectives, and also senior management or executives should make sure that there is alignment with cooperate strategy and obsolescence management strategy to improve business performance. The other area of concern from the results was the lack of awareness, funding and dedicated team from the employees about the topic of obsolescence management. It is recommended that the Power Utility initiates a training programme to create awareness of obsolescence management and further allocates the team which is responsible for promoting and managing obsolescence within the power utility. The team should be provided with all the funding in order to promote obsolescence management to support the business.

5.3 Conclusion

The main purpose of the study was to assess the obsolescence management policies and practices adopted by the Power Utilities in South Africa. The study included the review of the existing literature, and documents in the field of obsolescence management.

The study used both primary and secondary data to answer the research questions. The secondary data was collected from asset management systems, and the primary data was collected through online survey. The study further used both qualitative and quantitative methods to analyse and interpret data.

The results of the study indicate that the Power Utility was reactive in managing obsolescence and there was lack of understanding of obsolescence management. Furthermore, the study demonstrated that there was no dedicated team and funding allocated to obsolescence management. It is recommended that Power Utilities adopt more proactive approach in managing obsolescence. The executives should identify or create training programmes to propagate awareness within the organisation.

5.4 Study Limitations

The results of the study cannot be generalised to other Power Utilities outside South Africa. The study also excluded independent Power Producers like municipalities. The employees who did not have access to computes did not get the opportunity to participate in the study. The data analysed from asset management was also limited to 5 years.

5.5 Further Studies

- Benchmarking Obsolescence management practices across government owned companies.
- Cost of Obsolescence management within the Power Utilities.
- How will the 4.0 drive strategy change the way obsolescence is managed in Power Utilities.

REREFENCES

[1] M. B. Miller and A. M. Huberman, *Qualitative Data analysis,* 1984.

[2] A. Meyer, L. Pretorious and J. Pretorious, "A Model to Manage Electronic Components Obsolesence for complex or Long Life Systsmes," South Africa, 2004.

[3] F. J. Romero Rojo, R. Rajkumar and E. Shehab, "Obsolescence management for long-life contracts: state," 2009.

[4] J. T. Walter, ARINC and Annapolis, "Component Obsolescence Mitigation Strategies," Annapolis, 2003.

[5] C. J. a. J. P. Terpenny, "Component Obsolescence Risk Assessment," Univeristy of Masauchusetts, Amherst.

[6] E. J. Devereaux, "Obsolesence: A System Engineering and Management Approach for Complex Systems," 2010.

[7] F. Brit and R. L. Morgan, "Obsolesence Management and Mitigation," Arsenal, 2007.

[8] P. Sandborn, "Beyond Reactive Thinking – We Should be Developing Pro-Active Approaches," 2004.

[9] P. A. S. Rajeev Solomon, "Life Cycle Concepts and Obsolescence," 2000.

[10] L. Condra, "Combating Electronic Component Obsolescence by Using Common Processes".

[11] M. B. T. a. L. O. Xiaozhou Meng, "Strategic Proactive Obsolescence Management Model," *IEEE,* 2014.

[12] D. Collection, "Data Collection," Mathew Hermand, Columbia, 2013.

[13] S. E. F. a. M. A. Waller, "Can we stay ahead of the Obsolesence Curve".

[14] Ellis F. Hitt Battelle&Jerry Schmidt Battelle, "Technology Obsolesense impacts Future costs," 1998.

[15] M. Ellis, *Systems-Engineering Approach to Technology,* 2006.

[16] U. Journal, "Research Design, Method and Population," 3003.

[17] I. A. Energy, "Handbook of Ageing Management," 2014.

[18] R. D. Mohsen Tavakol, *Making sense of Cronbach's alpha,* 2011.

[19] M. B. T. a. L. O. Xiaozhou Meng, "Strategic Proactive Obsolescence Management Model," *IEEE,* vol. 4, 2014.

[20] R. D. Mohsen Tavakol, *Making sense of Cronbach's alpha,* 2011.

[21] X. Meng, B. ThornBerg and L. Olsson, "Component Obsolescence Management Model for Long Life Cycle Embedded System," *IEEE,* 2012.

[22] D. A. C. a. E. Ehlers, "Biologically Inspired Obsolescence Management," 2011.

[23] J. A. E. &. R. Roy, "Understanding service uncertainties in industrial," 2011.

[24] P. Sandborn, "Complicating the Part and Technology Obsolescence," 2007.

[25] P. Sandborn, "Designing for Technology Obsolescence Management," 2007.

[26] S. E. F. a. M. A. Waller, "Can We Stay Ahead of the Obsolescence Curve?," 2014.

[27] R. Yin, *Research Design and methods,* 2003.

[28] C. a. Yeates, *Pearson Education : Project Management for Information System,* 2008.

[29] W. M. Vagias, *Likert scale response. ,* 2006..

[30] &. R. D. M Tavakol, " Making sense of Cronbach's alpha.," 2011.

[31] J. H. &. D. D. ED de Leeuw, *International Handbook of Survey Methodology,* 2008.

[32] S. Monkey, "https://www.surveymonkey.com/analyze/dZNPM59qmq6Ft2VCG0R9c6rk1j2Jpnu3nyXlwHXOd2A_3D," *Obsolesence Managaement Survey,* 2017.

[33] B. F. R. L. Morgan, "Obsolesence Management and Mitigation," 2007.

[34] F. J. R. R. &. R. Roy, "Obsolescence management for long-life contracts: state," 2009.

[35] P. A. S. Rajeev Solomon, "Life Cycle Concepts and Obsolescence," 2000.

[36] S. E. Fawcett and M. A. Waller, "Can we stay ahead of the Obsolesence Curve," vol. 35, p. 22, 2014.

Survey Questionnaires

University of Johannesburg
APK Campus
Private Bag

Date: 24 August 2017

Dear participant,

Re: Obsolescence Management the study of Power Utility in South Africa

I am currently registered for Masters of Engineering management with University of Johannesburg. As a partial requirement for the completion of this degree, I am required to undertake a research project. The title of the research is "**Obsolescence Management the study of Power Utility in South Africa** ". The objective of the study is to assess engineers' views levels with respect to obsolescence Management planning process on technology ageing.

The study entails a survey in a form of structured questionnaires. Your participation in this study will be much appreciated as it will assist in the completion of the research project. It should take approximately 10 minutes to complete the questionnaire. Your views and contribution to this study will be treated with confidentiality and your anonymity will be assured. The findings of the research will be made available to participants upon request.
Please return the completed questionnaire to Nomatshawe Gantsho on the e-mail addresses shown below:
Gantshonl@gmail.com
Gantshon@eskom.co.za

The researcher hereby kindly emphasises that the success of this study depends on your participation.
Your co-operation is highly appreciated in advance.

Yours Sincerely
Nomatshawe Gantsho
Researcher
Tel: (011) 800 2413
Cell: 084 438 5063
Research Supervisor: Prof. JHC Pretorius
Research Co- Supervisor: Bheki Mkhanya

Section A: General Information

In this section, we would like to know about you in general. Please tick (×)

1) How long have you been in asset management/ engineering line of work?

- 0-1 years
- 1-5 years
- 5 -10 years
- 10–15 years
- 15 – 20 years
- More than 20 years

2) About how long have you been in your current position?

- 0-1 years
- 1-5 years
- 5 -10 years
- 10–15 years
- 15 – 20 years
- More than 20 years

3) How would you describe your level of responsibilities?

- Engineer
- Senior Engineer
- Principal Engineer
- Chief Engineer
- Technologist
- Senior Technologist
- Engineering Technician
- Artisan
- Engineering Manager
- Other (Specify)__________________________

4) Which of the following best describes the field in which you received your highest educational qualification?

- ◯ Mathematics
- ◯ Science
- ◯ Health Care
- ◯ Medicine
- ◯ Computing
- ◯ Engineering
- ◯ Technology
- ◯ Business

5) Which of the following best describes your highest educational qualification?

- ◯ Grade 12
- ◯ Certificate
- ◯ National Diploma
- ◯ BSc or BEng
- ◯ Masters
- ◯ Ph.D
- ◯ Other (Specify)________________________

6) How would you describe your age group?

- ◯ 15- 20 years
- ◯ 20 -25 years
- ◯ 25- 30 years
- ◯ 30-35 years
- ◯ 35 –40 years
- ◯ 40 – 50 years
- ◯ More than 50 years

Section B: The perception about obsolescence management process

1) The section is asking for your view about obsolescence management process within your line of duty. The statements below are presented for your evaluation. Please select the number of responses which best represent your level of agreement.

1= Strongly disagree 2= Disagree 3= Neutral 4= Agree 5 = Strongly Agree

Statement	**1**	**2**	**3**	**4**	**5**
1. There is a separate policy for Obsolescence Management					
2. The Obsolescence management form part of the asset management strategy					
3. There is independent team responsible for obsolescence management					
4. There are regular workshops to create awareness about the role of obsolescence management process					
5. Senior Management fully supports the current obsolescence management practice					
6. Obsolescence procedures are easy to understand					
7. Obsolescence documents are easy to understand					
8. The current obsolescence management strategy supports the business objectives					

2) In your opinion, what are the challenges associated with the current obsolescence management strategy?

____

____

3) Any suggestions to improve the current situation or future developments?

End